The search for HMAS AE1

Solving a 103-year-old mystery

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How the latest hydrographic surveying techniques discovered the first Allied submarine to be lost in WW1

AUSTRALIA'S oldest naval mystery has been solved – 103 years after the 54.2m long First World War Australian submarine *HMAS AE1*, the most technologically advanced in the world at the time, vanished off Rabaul, Papua New Guinea. She had been in operation for just seven months.

The submarine, with her 35-man crew of Australian, New Zealand and British subjects, joined the naval forces assigned to the capture of the German Pacific colonies. With *AE2*, she took part in the operations leading to the occupation of German New Guinea, including the surrender of Rabaul on 13 September 1914. The following day she became the first Allied submarine lost in the First World War, and the first ship lost by the Royal Australian Navy.

It is only now that facts have been revealed about what caused *AE1* to vanish without trace. Naturally there were searches instigated at the time. Since 1976, 12 searches have been undertaken to establish her location; but until 2017 none of these had been successful.

On 19 December 2017 a new search, the 13th, this time conducted by Fugro using its vessel *Fugro Equator* and her autonomous underwater vehicle (AUV) *Echo Surveyor V*, located an object of interest. Further inspection confirmed it was the wreck of *AE1* in over 300m of water off the Duke of York Islands. On 21 December 2017 the Australian government formally announced that the exact location of the wreck would not be publicly disclosed as it would be declared a War Grave; governments are now working on the best measures to protect the site.

Understanding what happened

A report revealing the probable cause of the incident 103 years ago was published on 12 March 2018: *"Understanding exactly what befell AE1 and the men on board is limited by the location of the wreck site (at considerable depth within a foreign nation's territorial waters) and damage to the hull and its associated material culture caused by the passage of time,"* concludes the report published by the expedition team on 12 March 2018. Despite these limitations and challenges, examination of acoustic, video and still imagery acquired during the 2017 survey has provided a reasonable level of understanding of what led to the submarine's loss:

> *"AE1 was probably already submerged or in the process of diving when the accident occurred, and the wreck's position is consistent with a course to return to Rabaul. It appears that the submarine experienced a depth excursion and exceeded its 'crush depth', leading to the implosion of the hull forward of the fin in the control room area and over the forward torpedo compartment. The flooded submarine sank rapidly to the bottom and probably landing on its keel, with a moderate bow down angle before pitching forward, to strike the seabed with its bow. This resulted in a whiplash effect*

A photo-mosaic of the AE1, from data captured from the sea surface during the successful search in December 2017.

that dislodged the fin and caused it to tilt forward onto the partially collapsed forward casing."

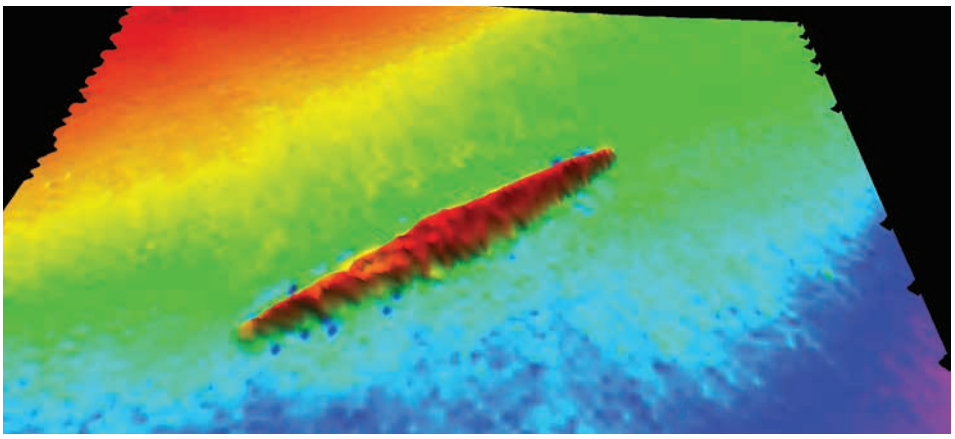
The search

The 2017 success was the result of a large team of dedicated people putting in many years of work on the project. Their input helped to narrow down the area in which to search.

The plans were a long time coming to fruition. Fugro began talking about how to find *AE1* in 2015, based on research undertaken by Retired Rear Admiral Peter Briggs, leader of the Find AE1 Foundation, the Royal Australian Navy, the Australian National Maritime Museum and the Defence Science and Technology Group. This involved going through historical records; learning just how the vessel operated; and gathering information on the terrain, even though the location of where *AE1* sank remained a mystery.

This latest search was not scheduled to take place until 2018, but fortuitously Fugro was in the area undertaking deep water work for the resources sector off Papua New Guinea, and after this work was completed *Fugro Equator* could be used for the *AE1* search. The unexpected availability of the vessel brought the project forward.

Fugro Equator is very much a 21st century survey vessel. The specially designed hull, diesel electric drive and rudder propellers maximise fuel efficiency, navigational control and station keeping capabilities. During her design great attention was paid to minimising conducted vibration from vessel mounted machinery and infrastructure, resulting in an acoustically quiet platform, enabling high quality data collection. Permanently installed equipment includes digital seismic, seabed and sub seabed mapping systems. Acoustic positioning is provided by a through-hull ultra-short baseline (USBL) system and Fugro's Starfix high precision GNSS services takes care of surface positioning. All acquisition, navigation, processing, charting and reporting systems are networked and integrated through industrial grade servers.



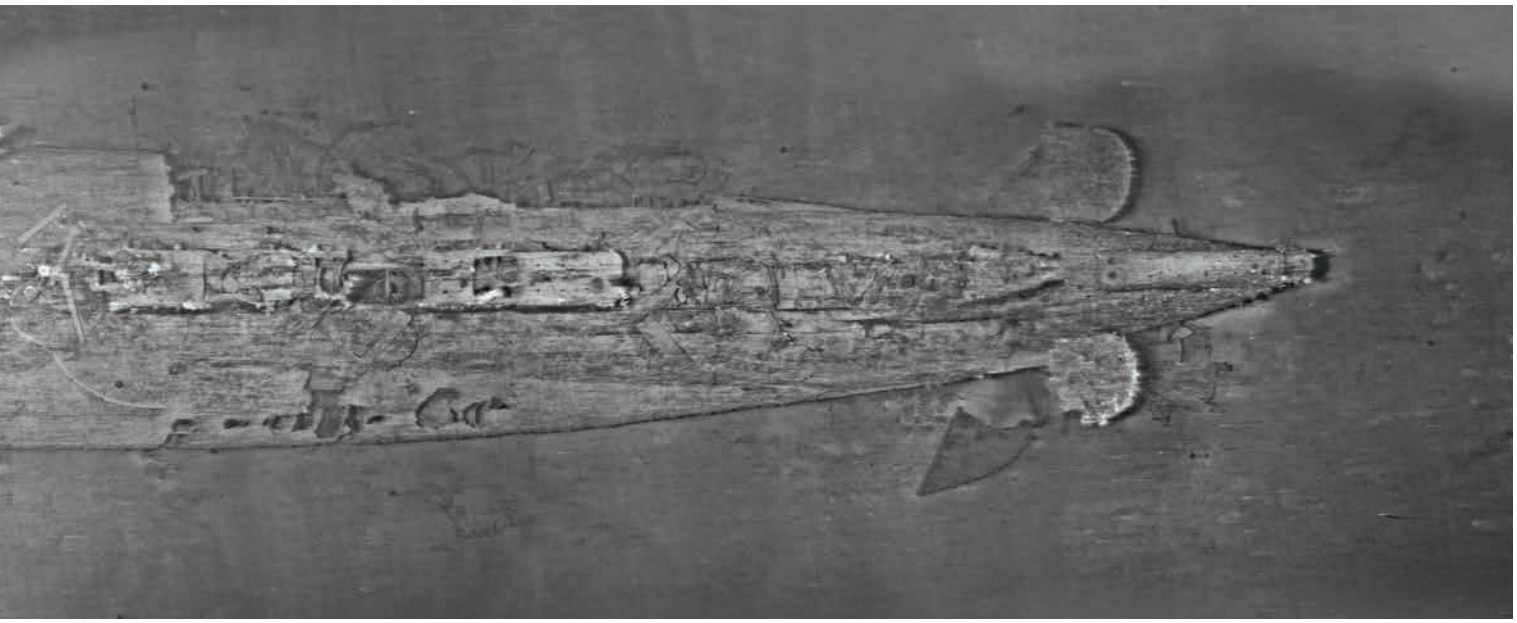
Survey data revealed an object of interest in over 300m of water off the Duke of York Islands.

One of the things that helped lead to the success of the mission was undoubtedly the use of the right equipment for the water depths in which the search team was operating, including a multibeam echosounder mounted on the hull of *Fugro Equator*. Previous searches had focused on shallow water areas because of the limitations of the multibeam systems used. Fugro looked initially at using a deep tow system, which can be an effective tool, but given the terrain, which drops off quite steeply, it would have been extremely difficult to operate.

Deploying the AUV, *Echo Surveyor V*, and flying it at a constant altitude of 35m, proved the right tool for the job. The deep tow system would have travelled across the top of the undersea mountains and not into their valleys. Placing survey sensors on board an AUV means the geophysical measurements take place close to the seafloor (or the object being surveyed), dramatically improving data resolution and accuracy.

Echo Surveyor V was specifically designed for high resolution and efficient survey operations in water depths down to 3,000m. It is based on the Kongsberg Hugin 1000 body with a payload selected to meet the demands of the offshore survey industry. For example, its tight turning circle (compared to that of a towed system) enormously reduces the time to change between survey lines. It features radio and Iridium surface communications, acoustic telemetry systems, USBL, inertial navigation system (INS), Doppler, altimeter, depth sensor, conductivity- temperature recorders (CTD), forward looking obstacle avoidance sonar; multibeam echo sounder, side scan sonar, sub bottom profiler and camera – it was just what was needed for this historic search.

The biggest challenge was the terrain. Not only is the area very steep but there are strong ocean currents between two land masses, particularly along the north/south survey lines. This affected the amount of time the AUV could operate



Photograph showing the helm of *AE1* in its final resting place.

in the water. Severe weather also affected the search conditions, including a Force 3 wind from the northwest, thunder and showers – not ideal conditions for a search.

Another challenge was the fact that there was only a limited number of days in which to undertake the search. Given that success within the primary search area was by no means guaranteed, committing to undertake it in an area that was potentially very large was a bold step; beyond the primary search area is a very large expanse of ocean.

The find

Echo Surveyor V scanned the seafloor to collect detailed data. The large team on board, including the National Maritime Museum, the Find AE1 Foundation and Rear Admiral Briggs, were there with the Fugro team as they analysed what was coming in. The resulting 1m resolution images provided confidence that positive identification of targets could be made. Following analysis of the data, unusual features were catalogued, assessed and prioritised for additional detailed investigation that included AUV and drop camera operations. The first images captured show the vessel is remarkably well preserved and apparently in one piece.

The SeaBug drop camera was an extremely useful tool. It sits at the end of a long cable and is literally dropped into place. Like the AUV it is 3,000m rated; and it provides real time video, 14.7 mega pixel digital stills; has a 5x optic zoom and dual lasers mounted to provide image scaling. That's what captured many of the close-up pictures from the dynamically positioned vessel when in station-keeping mode. There are two different types of image – the one of the entire submarine itself (which is a photo mosaic captured from the sea surface) and others taken as single shots close to the seafloor.

The conning tower and other protruding elements of the submarine prevented Fugro operating the AUV closer to the sunken vessel but nevertheless, the photographs from both the drop camera and the AUV are sensational.

What next for AE1?

Following the discovery of the submarine, a small commemorative service was conducted onboard the Fugro Equator to remember the 35 crew who lost their lives in 1914.

The information gained from this expedition will be held by the Australian National Maritime Museum for future generations to remember, a fact that is particularly rewarding for the mission team to know.

That the search was successful can be attributed to three components: thorough planning; a professional team with the right equipment; and a little bit of luck.

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